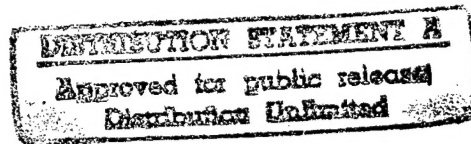




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# ***JPRS Report***



# **Science & Technology**

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# Science & Technology

## Central Eurasia: Earth Sciences

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### Oceanic Meso- and Microstratification

927N0067A Moscow DOKLADY AKADEMII NAUK  
in Russian Vol 321 No 3, Nov 91 pp 599-603

[Article by N. N. Kolchitskiy, corresponding member, USSR Academy of Sciences, A. S. Monin, V. T. Paka and Z. Ye. Entin, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; UDC 551.46]

[Abstract] Ordinary high-resolution temperature-conductivity-depth sounding at fixed points reveals a vertical thin-layered oceanic microstructure in the form of steps on the vertical profiles of thermodynamic characteristics with layer thicknesses from several meters to decimeters, but without information on their horizontal structure. This deficiency has been rectified by the introduction of a so-called scanning thermohaline trawl, a system of several (5-6) temperature-conductivity depth probes spaced about 5 m apart on a single cable alternately raised and lowered while a ship is proceeding on course in a vertical distance of about 10 m so that the probes synchronously describe parallel sawtooth trajectories in slightly overlapping 10-m ocean layers. The first copy of this instrument, tested in the Mediterranean Sea in early May 1990, yielded fundamentally new results. Examples are given for two temperature field sections in the layer 40-85 m, revealing earlier unsuspected formations. The temperature sections illustrated and described in the article convincingly demonstrate the presence and evidently widespread occurrence of a distinct microstructure in the upper oceanic layer in the form of pancake-shaped water lenses with thicknesses from meters to tens of meters and horizontal dimensions on the order of kilometers. Figures 2; references: 3 Russian.

### Some Types of Black Sea Surface Currents

927N0066B Moscow DOKLADY AKADEMII NAUK  
SSSR in Russian Vol 320 No 1, Sep 91 pp 199-203

[Article by I. F. Gertman, V. N. Yeremeyev, L. M. Ivanov, S. V. Kochergin and O. V. Melnichenko, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol; UDC 551.46(262.5)]

[Abstract] One of the important unsolved problems for the Black Sea is the generation of the large-scale circulation characteristic for this basin. Attempts at explaining it within the framework of classical oceanographic concepts have been unsuccessful because the heuristic considerations serving as their basis made it impossible to determine clearly the relationship between the energy supply sources for the currents and the types of currents which assimilate energy. Numerical simulation of Black Sea circulation also failed to clarify this problem. It was decided that the main reason for the failures has been the lack of a method for unambiguous finding of the types of currents which can be generated in the Black Sea basin. Accordingly, a method was used involving expansion of vectorial velocity fields in a set of base functions (modes). Its application to the results of computations of large-scale circulation in a numerical baroclinic model

made it possible to discriminate definite types of currents in the upper layer of the Black Sea and to investigate their seasonal variability. The mapping and analysis of the results indicated that intensification of the modes  $n = 1$  and  $n = 2$  in winter is related to restructuring of waters in the central part of the sea. The principal energy supply source of the modes is evidently powerful penetrating convection. The spring maxima of the modes  $n = 3$  and  $n = 4$  are related to reorganization of the horizontal structure of waters in the western part of the Black Sea. Such changes are naturally determined by a spring increase in river runoff (the maximum river runoff occurs in May). The presence of other extrema in the spectral characteristics of the modes  $n = 1, 2, 3, 4$  is related to nonlinear interactions among different modes. As a result of such interactions energy flows of different directions are generated both from larger-scale to smaller-scale modes and vice versa. Figures 3; references: 2 Russian.

### Meridional Transport of Heat in Oceans and Its Seasonal Changes

927N0058B Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 11, Nov 91 pp 76-84

[Article by L. A. Strokina, State Hydrological Institute; UDC 551.463.6:551.461.6]

[Abstract] Quantitative discrepancies in estimates of seasonal variations in meridional heat transport  $T_0$  in the ocean given in the literature are attributable primarily to the differing reliability of existing methods for determining meridional heat transport and an inadequate accuracy of the data necessary for computing  $T_0$ . Accordingly, a method is proposed for estimating the meridional transport of heat in the world ocean and in individual oceanic basins involving use of an equation for the thermal budget for the ocean surface and data on the rate of heat content change in the active layer. Materials on  $T_0$  in the oceans of both hemispheres are compared. Data are given on meridional heat transport in the oceans of the southern hemisphere in winter directed not southward, but northward, which is distinctly different from the approach used by other authors. Due to the action of the North Atlantic Current, in the North Atlantic there is an intensification of heat convergence with an increase in latitude, whereas in the South Atlantic convergence is weakened. There are clearly expressed differences in heat transport by currents in the northern and southern parts of the Pacific Ocean where there is weak heat convergence and divergence in the latitude zone between  $25^\circ$  and  $45^\circ\text{N}$  and considerable convergence in this same latitude zone in the southern hemisphere. A distinguishing climatic feature of the southern ocean in winter is heat convergence over a considerable part of the ocean caused for the most part by heat receipts at the ocean surface from the lower-lying layers which exceed water cooling in the active layer. Figures 3; references 27; 7 Russian, 20 Western.

**Method for Computing Short-Range Changes in Ocean Water Temperature**

927N0058C Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 11, Nov 91 pp 85-88

[Article by V. V. Yelisov, State Oceanographic Institute; UDC 551.465.62.001.572]

[Abstract] A method is proposed for computing short-range changes in water temperature in the ocean in which the results are obtained by correcting numerical simulation data by using information from inertial and climatic computations. The method was checked using such data as daily surface pressure charts and five-day ocean surface temperature (OST) charts for the North Atlantic. Information was used for the period 3 May-28 September 1986 (148 pressure fields and 30 OST charts) with data plotted in a 2° grid. Three different tests were used in evaluating accuracy and three types of computations were made. The first method was numerical simulation, in which use is made of a local model of thermal structure, making it possible to compute the vertical distribution of water temperature within the limits of the active layer of the ocean. The second method was inertial computations and in the third the OST climatic value for the day N+1 was used as the computation field. Twenty-nine such computations were made. A comparison revealed that the quality of computations by both the hydrodynamic and inertial methods is approximately identical. The second method is somewhat superior, but in contrast to the hydrodynamic model this method does not make it possible to determine the temperature distribution in the active layer. The results of climatic computations are considerably poorer, although there is a high correlation between water temperature changes. In general, the regions of errors are the same geographically, but there is no complete coincidence. The best results are obtained using a weighted combination of the three methods. Figure 1; references: 11 Russian.

**Dispersion Relation for Envelopes of Wind Wave Groups**

927N0057B Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA* in Russian Vol 27 No 8, Aug 91 pp 847-852

[Article by V. V. Yefimov and A. V. Babanin, Marine Hydrophysics Institute; UDC 551.466.3]

[Abstract] The dispersion relation for envelopes of wind surface waves was investigated and data were collected making it possible to relate the space and time scales of wave groups. The research was carried out in 1986-1989 using data from in situ observations in the northwestern Black Sea. The observation region and methods for measuring wind waves were described in detail by V. V. Yefimov, et al. in *METEOROLOGIYA I GIDROLOGIYA*, No 11, pp 68-75, 1986. The properties of the wave groups were studied using records with a duration of several hours registered under stable hydrometeorological conditions. It is shown that the rate

of transfer of wind wave energy is a spectral constant and its changes are related to changes in the wave spectrum. It was found that the group velocity in the wind wave system is determined by the position of the mean frequency in the wave spectrum; in a wide range of conditions for the existence of waves it constitutes 40 percent of the phase velocity of the spectral maximum component. The results make it clear that the findings on propagation of the envelopes of wave groups are readily explained within the framework of a linear representation. Figures 2; references 13: 9 Russian, 4 Western.

**Transformation of Sea Surface Slicks During Restructuring of Wind Wave Spectra**

927N0057C Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA* in Russian Vol 27 No 8, Aug 91 pp 862-866

[Article by S. I. Kozlov and T. G. Talipova, State Oceanographic Institute; UDC 551.466.38:551.466.8:551.465.5]

[Abstract] The concentrations of surfactants at the ocean surface are usually less than the threshold level and slicks are therefore formed in current convergence zones where the film concentration increases. These zones develop in large-scale oceanic processes such as Langmuir cells, internal waves, nonuniform surface currents and eddies. Slicks can therefore serve as indicators of these processes. A study was made of the influence of variability of the processes of exchange of organic matter between the surface and subsurface water layers during restructuring of the spectra of surface waves on the general level of concentration of surfactant film on the sea surface. An estimate of the relative change in film concentration in the field of internal wave currents also was made with allowance for change in the spectrum of wind waves by this current. The position of a slick relative to internal wave phase is dependent on film relaxation time. In the case of short film relaxation times the position of the slick coincides with the slick position in the decimeter range of the wind wave spectrum. In slowly relaxing films the maximum of the concentration of surfactants is over the foot of an internal wave. With an increase in relaxation time such a slick is displaced to the foot of an internal wave. In the presence of rapidly relaxing films there may be a coincidence of the positions of slicks in the decimeter and centimeter parts of the spectrum relative to the internal wave phase, a correlation which has been observed during in situ experiments. Figure 1; references 19: 10 Russian, 9 Western.

**Third-Generation Spectral Model for Wind Waves**

927N0057D Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA* in Russian Vol 27 No 8, Aug 91 pp 867-878

[Article by V. G. Polnikov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences; UDC 551.466.3]

[Abstract] The term "third-generation spectral model" was introduced in the SWAMP (Sea Wave Modeling Project) program in which the term NL in the source function F describes all the characteristic features of the precise integral of nonlinear energy transfer in the wave spectrum; the form of representation of the other terms G and D was left ambiguous because the processes which they describe were studied in far lesser detail. The WADMI (Wave Modeling Development and Implementation) group has now developed third-generation models intended for solving wave prediction problems under different wave formation conditions. The WAM3D model, for example, in some respects is extremely effective under both quite simple and quite complex wave formation conditions, but an inadequacy is poor theoretical validation of the G and D terms in the source function, making it impossible to solve research problems. The process of stabilization of the equilibrium part of the spectrum also is not described in the WAM3D model and the latter is characterized by a number of other inadmissible deficiencies. However, a number of new G, NL and D parametrizations have become available which in turn allow formulation of a new parametrization of the source function in a numerical spectral model of wind waves. A model developed by the author on this basis was tested in the example of four test problems, each of which is described in detail. A number of new effects in evolution of the wave spectrum are noted. The possibilities for using the model as a tool for investigating the physics of wind waves are outlined. Figures 4; references 16: 7 Russian, 9 Western.

#### Longitudinal and Transverse Coherence in Energy-Bearing Sea Wind Waves

927N0057E Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERI I OKEANA in Russian Vol 27 No 8, Aug 91 pp 887-889

[Article by G. N. Khristoforov, V. Ye. Smolov and A. S. Zapevalov, Marine Hydrophysics Institute, Ukrainian Academy of Sciences; UDC 551.466.3]

[Abstract] Data are given on in situ observations characterizing coherence loss in energy-bearing waves. The measurements were made during 1988-1989 at an oceanographic platform of the Marine Hydrophysics Institute at Katsiveli. The instruments and methods were described earlier by the authors in IZV. AN SSSR: FAO, Vol 25, No 6, pp 636-643, 1989. The measurements were made with short distances between the wave recorders (0.2-2.4 m) and with great distances (5-20 m); base orientation was in longitudinal and transverse directions to the wind; the measurements were made in a wide range of meteorological conditions (wind speeds 1-2 to 20 m/s), making it possible to determine the coherences with lengths of the energy-bearing waves from 2 to 40 m. During each series measurements were made on different bases with longitudinal and transverse orientations: 37 coherence measurements in a transverse direction, 108 in a longitudinal direction. The registered data differed in a number of respects from the principal

theoretical models of wind waves. In particular, G. T. Komen (JGR, Vol 5, No C6, 1980) examined linear coherence functions for several models including the two principal physical mechanisms resulting in coherence loss: with angular broadening of propagation of spectral components and with allowance for nonlinear components in the wave spectrum. The linear coherence functions cited by Komen were scaled to quadratic components and compared with the new data. It was found that the observed rate of coherence dropoff with distance in the sea is considerably higher than in theory. Moreover, the asymmetry of coherence computed using the expressions cited by Komen indicated a behavior opposite the experimental curve: it follows from theory that in energy-bearing waves longitudinal coherence is greater than transverse coherence, but observations give the opposite relation. Figures 2; references 5: 3 Russian, 2 Western.

#### Influence of Pollutants on Sea Surface Temperature Regime

927N0057F Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERI I OKEANA in Russian Vol 27 No 8, Aug 91 pp 889-891

[Article by V. V. Ivanov and V. M. Chekryzhov, Experimental Meteorology Institute; UDC 551.465.7]

[Abstract] In an earlier study (IZV. AN SSSR: FAO, Vol 25, No 2, pp 202-206, 1989) the authors demonstrated that a  $\Delta T$  (temperature drop between the surface and the underlying layers) increase in the sea can be caused by a decrease in water surface tension due to presence of oil films. In order to confirm the relationship between  $\Delta T$  and the degree of water surface pollution as detected in the laboratory it was necessary to carry out an in situ experiment. A relatively easily measured physical characteristic of the degree of surface pollution by surfactant films is surface pressure P, determined as the difference in surface tensions of pure and polluted water. Such an experiment was carried out in June and September 1988 for study of the dependence  $\Delta T = f(P)$  under marine conditions. A series of simultaneous measurements of  $\Delta T$  in the surface layer and surface pressure in the coastal waters of the Black Sea was carried out at an oceanographic platform of the Marine Hydrophysics Institute when there was a neutral or nearly neutral stratification and with absence of solar heating of surface layers. It was found that under these conditions the presence of surfactant films on the surface results in a considerable thickening of the near-surface layer, processes in which are determined by molecular diffusion. As a result it was possible to observe a considerable (up to twofold) increase in  $\Delta T$  in this layer, which in turn results in a decrease in the radiation temperature of the water surface. The dependence of  $\Delta T$  on surface pressure P in surfactant films observed under marine conditions makes possible at least an approximate allowance for their influence on the thermal regime of the near-surface water layer and water surface temperature. Figures 2; references 3: 2 Russian, 1 Western.



### Nonlinear Interaction of Two-Dimensional Packets of Monochromatic Internal Waves

927N0037B Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 12, Dec 91 pp 1292-1301

[Article by A. V. Kistovich and Yu. D. Chashechkin, Mechanical Problems Institute, USSR Academy of Sciences; UDC 551.466.3]

[Abstract] A study was made of the nonlinear interaction of two monochromatic packets of internal waves in a nonviscous stratified fluid. Corrections to the density distribution and the velocity field necessitated by nonlinear interaction in both resonance and nonresonance cases were computed for the case of weak interaction. It is shown that the interaction intensity is dependent not only on the intensity of the sources, but also on the form of the distribution functions of the amplitudes of velocities in the packets and on their space derivatives. The contributions of the different nonlinear mechanisms are compared. In the case of resonance interaction the condition for the generation of a packet of a difference frequency is determined and it is shown that in the limiting case of plane waves the generation condition is reduced to the standard synchronism condition. Resonance interaction leads to the appearance of large-scale modulations of the velocity field and the density distribution. The scale of long-wave modulations is inversely proportional to the small parameter of the problem. The relative contribution of nonlinear effects to the interaction picture will be conserved to zero intensities of the sources of internal waves, which is related to the dependence of the intensity of nonlinear effects not only on the velocity distribution functions for the packets, but also on their first and second derivatives. Figure 1; references 14: 7 Russian, 7 Western.

### Probability Density Function of Gaussian Curvature of Sea Surface at Specular Reflection Points

927N0037D Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 12, Dec 91 pp 1367-1371

[Article by R. G. Gardashov, Mathematics and Mechanics Institute, Azerbaidjan Academy of Sciences; UDC 551.466.326]

[Abstract] An important research field is study of the interaction between light and the sea surface (study of the possibility of determining scattering surface parameters on the basis of the characteristics of the strength of the signals reflected by it). In seeking a solution of this problem it is assumed that the sea surface rise is a random homogeneous Gaussian field. The mean number of specular reflection points (N) was determined for such a surface by Longuet-Higgins, who also found the density distribution  $W(K)$  of Gaussian curvature at such specular reflection points (this density was expressed through some integral of a complex variable). In this article,

while working largely with the foundation laid by Longuet-Higgins, a different representation (through an integral containing a function of errors) is obtained for this same distribution density  $W(K)$ , one which is more convenient for computer computations. An analytic expression is derived for the probability density function for the Gaussian curvature of the surface at specular reflection points and its asymptotic form is found for high values of Gaussian curvature. An example of the computations is given. Figure 1; references 5: 4 Russian, 1 Western.

### Slightly Nonlinear Evolution of Wave Spectrum in Shallow Waters

927N0037E Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 12, Dec 91 pp 1372-1378

[Article by I. V. Lavrenov, State Oceanographic Institute; UDC 551.466]

[Abstract] The slightly nonlinear interaction of waves is one of the principal mechanisms determining the formation and evolution of the spectrum of wind waves. The role of this mechanism is a conservative redistribution of energy in the wave spectrum. There have been few and only fragmentary attempts at numerical solution of the evolutionary problem with full computation of the collisions integral and these were made only for a spatially homogeneous case. Accordingly, on the basis of numerical solution of the pertinent kinetic equation a study was made of the slightly nonlinear evolution of the wave spectrum in a basin of finite depth. The objective of the numerical computations was research on the influence of basin depth on the slightly nonlinear transfer of energy and evolution of the spectrum. The JONSWAP spectrum was used in describing wind waves. The results make it possible to explain the usually observed picture of transformation of waves in the coastal zone of the sea when quasiregular waves with a quite narrow spectrum, with approach of the waves to the surf zone, are separated from the field of waves having a quite random character in deep water. Whereas the energy angular distribution function is narrowed primarily due to the refraction of waves with a decrease in depth, narrowing of the frequency spectrum can be attributed to the nonlinear action of waves. Formulas 4; references 7: 4 Russian, 3 Western.

### Detection of Intrathermocline Lenses Using Echo Sounder

927N0036A Moscow OKEANOLOGIYA in Russian  
Vol 31 No 6, Nov-Dec 91 pp 1067-1070

[Article by L. A. Dykhno and B. N. Filyushkin, Atlantic Division, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; UDC 551.46.07]

[Abstract] A study was made of the possibility of using a simple noncontact method for detecting intrathermocline lenses and tracking them using a shipborne echo sounder. The experiments were carried out in the Canary Basin in the Atlantic Ocean on the second cruise of the Akademik Ioffe research ship in November 1989. The method is based on the assumption that in the lens there is suspended matter forming sound-scattering layers which are usually registered by echo sounders (the lenses are formed in shelf zones rich in terrigenous and biogenous suspended matter). The studied lens was located at a depth of 600-1500 m, had a diameter of about 100 km and a volume about 3500 km<sup>3</sup>. The lens had strong temperature and salinity inversions differing from the background values by 4°C and 0.8 percent. The values of these parameters in the lens core were evidence of its Mediterranean origin. Echo sounding was while the ship was on course and at stations. The Parasound sounder operated at 33 kHz. The research revealed the importance of systematic echo sounding when seeking and studying the nature of evolution and movement of intramass lens formations of Mediterranean origin. Further accumulation of this type of information will make it possible to simplify the method for seeking lens formations. Figures 3; references 7: 6 Russian, 1 Western.

#### Determining Speed of Sound in Sea Sediments by Remote Acoustic Methods

927N0036B Moscow OKEANOLOGIYA in Russian  
Vol 31 No 6, Nov-Dec 91 pp 1071-1075

[Article by N. N. Dmitrevskiy, V. N. Kuznetsov, A. V. Kulikov, A. V. Nosov and T. G. Kharatishvili, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; UDC 551.46.082.534]

[Abstract] A remote acoustic method for determining the speed of sound in a plane homogeneous near-bottom layer using multiray echo sounding systems is described. A study is made of a model with an even bottom in the form of a homogeneous layer of constant thickness on a well-reflecting half-space. The sole requirement is that the echo sounding system must ensure reliable registry of signals backscattered by the water-sediments and sediments-lower half-space interfaces in the range of angles about  $\pm 40^\circ$  from the vertical. An MBL multiray towed sounder was employed. The experiments were made at depths about 300 m and with a thickness of the layers up to 40 m. But there is evidence that in the future it will become applicable to depths 4-5 km and for a layer thickness up to 50-60 m. The method was tested on the 1st cruise of the Akademik Sergey Vavilov research ship and the 13th cruise of the Rift. The cited results apply to two bottom sectors, substantially differing in their geology, selected to demonstrate that the method is applicable under quite varied conditions: the Sierra Leone Rise and the Mediterranean shelf zone. Figures 3; references 7: 5 Russian, 2 Western.

#### Observation and Quasi-Geostrophic Analysis of Synoptic Perturbations on "Poligon-70" Proving Ground

927N0026A Moscow OKEANOLOGIYA in Russian  
Vol 31 No 4, Jul-Aug 91 pp 540-549

[Article by B. V. Kharkov, Yu. M. Grachev, and I. V. Polyakova, Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; UDC 551.465.4]

[Abstract] An experiment was performed in the February-September 1970 period over a 195 km square area along the southern edge of the Atlantic Ocean's northern trade wind zone, 17 anchored buoys forming a cross with the center buoy located at 16°30' latitude north and 33°31' west having been equipped for direct measurement of currents within this "Poligon-70" proving ground. Measurements at each buoy were made along 10 horizontal lines, readings being taken every 30 min over periods of 84 h and passed through low-pass filters for extraction of the synoptic component. The kinetic energy of synoptic perturbations had been found to be maximum during the 18 May 1970 - 11 Jun 1970 period and, therefore, the data covering this period were selected for analysis. Numerical experiments were performed on the basis of a 4-level model, as the four levels along vertical lines having been selected four depths: 1) 100 m (under the upper quasi-homogeneous water layer and well within the 80-200 m deep pronounced seasonal pycnocline), 2) 400 m (upper boundary of 400-600 m deep layer of most intense synoptic perturbations), 3) 1000 m and 4) 1500 m (within lower layers of main thermocline). This model, a baroclinic quasi-geostrophic one with open boundaries describing the dynamics of synoptic processes over the given period, contained two equations for the quasi-geostrophic flow function  $\Psi$  and the potential vortex  $\zeta$ :  $\delta\zeta/\delta t + \epsilon I(\Psi, \zeta) = 0$  and  $\mu \Delta \Psi + y + \mu \delta(\sigma, \Psi)_z = \zeta$  with  $I(\Psi, \zeta)$  denoting the Jacobian of  $\Psi$  and  $\zeta$  as functions of both horizontal coordinates (x,y) (z-vertical coordinate, depth of ocean  $-H = 5$  km,  $W = 0$  at  $z = 0$  and at  $z = -H$ , velocity scale  $V_0 = 10$  cm/s, horizontal distance scale  $L_0 = 50$  km, vertical displacement scale  $H_0 = 700$  m, time scale  $t_0 = 252$  h, Coriolis parameter  $f_0 = 4.10 \times 10^{-5} \text{ s}^{-1}$ ,  $\epsilon = t_0 V/L = 1.8$ ,  $\mu = V/\beta_0 L^2 = 1.8$ ,  $\delta = (f_0 L/N_0 H_0)^2 = 1.3$ ,  $\sigma(z) = N_0^2/N^2(z)$ ,  $N(z)$ - Viasiali-Brent frequency profile, mean-thermocline Viasiali-Brent frequency at 700 m depth  $N_0 = 0.00255 \text{ s}^{-1}$ ). According to this model were, on the basis of experimental data, calculated not only the average density of kinetic energy and flow isolines but also the amplitudes of the barotropic and first three baroclinic modes as functions at various instants of time. The results indicate that fluctuations of the energy density of synoptic perturbations are coherent within the 200-1000 m deep layer and that buildup of synoptic perturbations due to barotropic instability requires an average northwest-to-southeast sloping of the perturbation isolines, their slope decreasing with increasing depth. The results are compared with results of other experiments such as the

Pinardi-Robinson POLYMODE experiment (JOURNAL OF OCEANOGRAPHY Vol 17, 1987). Figures 4; references 14.

### **Numerical Simulation of Transformation of Spectra of Internal Waves on Horizontally Nonuniform Currents**

927N0026B Moscow OKEANOLOGIYA in Russian Vol 31 No 4, Jul-Aug 91 pp 557-563

[Article by A. V. Ganopolskiy, Computer Center at USSR Academy of Sciences, and T. M. Uspenskaya, Institute of Acoustics imeni N. N. Andreyev, Moscow; UDC 551.466.81:551.465.8]

[Abstract] Transformation of the spatial and frequency spectra of internal waves on currents with large-scale nonuniformities such as those in the Pacific Ocean is analyzed the method of numerical simulation. As the model for this analysis is considered propagation of short internal waves, with wavelengths of the order of 100-1000 m and with small amplitudes, on steady currents with a characteristic nonuniformity scale of the order of 1000 m. It is furthermore assumed that there exists a spectrum of internal waves which becomes universal and isotropic at distances far from external perturbations, and that there exist mechanisms which relax perturbations of this spectrum so that it reaches its state of equilibrium within some characteristic time. Such a spectrum is described by the  $S_0(k) = Ak^{-2}$  relation, in accordance with the Garret-Manck model. On its basis are calculated trajectories of wave packets passing through a point  $x_0$  within the flow region at various angles and then propagating till they cross the boundary of that region. These calculations are made for a discrete set of wave frequencies  $\omega$ . The frequency spectrum  $S(x_0, \omega, m)$  of mode  $m$  is calculated by numerical integration of the corresponding spatial spectrum  $S(x_0, k, m)$  along equifrequency lines in the phase space of wave numbers  $k$ , in polar coordinates. Only the two lowest modes are considered, inasmuch as the higher-order ones are quite weak. The transformation of these spectra is then tracked on currents in an ideal conventional rectilinear jet, on currents in a more real meandering stream with a Rossby baroclinic deformation radius, and on currents in a synoptic vortex. The spatial spectra are found to become anisotropic, with most energy transferred to waves propagating at obtuse angles to the direction of flow. The frequency spectra are found to acquire a plateau and a local maximum near the blocking frequency, their transformation ratio depending largely on the relaxation time for perturbation of the spatial spectrum. It depends also on the flow velocity and geometry as well as on the dispersion characteristics of internal waves and thus on the conditions for flow stratification. The authors thank K.D. Sabinin and S.I. Badulin for fruitful discussion of the results. Figures 3; references 8.

### **Processing of Iron-Manganese Concretions and Turbidization of Benthic Ocean Layer**

927N0026C Moscow OKEANOLOGIYA in Russian Vol 31 No 4, Jul-Aug 91 pp 647-657

[Article by G. N. Baturin, T. A. Demidova, Ye. A. Kontar, and N. D. Kurlayev, Institute of Oceanography imeni P.P. Shirshov, Moscow, and Moscow Institute of Mining; UDC 551.462]

[Abstract] Extracting iron-manganese ore nodules from the ocean bed for future processing is considered, most promising from the utility standpoint being the bed of the Pacific Ocean in the eastern part of its equatorial zone (22-29 percent Mn, 0.9-1.5 percent Ni, 0.8-1.2 percent Cu, 0.20-0.27 percent Co). One problem involving this enterprise is turbidization of the ocean's benthic layer. Two kinds of methods have been proposed for extraction of these ores: 1) mechanical ones with a trawl or with two ropes and a scoop; 2) hydraulic transport using an air lift, or a submersed pump, or a compensation chamber. The four principal classes of sediments in the region of ore deposits are 1) argillaceous-radiolarian silts, 2) radiolarian-argillaceous silts, 3) foraminiferal-coccolithic silts, 4) miopelagic and eupelagic clays. Their density, porosity, and moisture as well as the velocity of flow in the benthic layer being essential factors to be considered in the design of ore extraction technology. An analysis of a wealth of available data indicates that extraction of ores from the bed inevitably disturbs the benthic medium by sharply increasing its local turbidity and possibly transforming the latter into regional turbidity. It can also intensify benthic flow by laminarizing the stream and consequently erode unstabilized sediment so that country rock in dense suspension is spread over various distances and redeposited somewhere else by gravity flow downward along bed slopes. Sediment transport storms with velocities up to 15 cm/s have been recorded in the benthic layer, even along bed slopes inclining at angles smaller than 1°. Figures 8; references 28 including 16 Western.

### **Dispersion of Internal Waves on Localized Inhomogeneities of Hydrophysical Fields**

927N0024A Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 27 No 7, Jul 91 pp 790-799

[Article by M. K. Bezhanova and V. V. Zhmur, Oceanology Institute, USSR Academy of Sciences; UDC 551.466.3]

[Abstract] In the geometrical optics approximation a study was made of the dispersion of internal waves on localized inhomogeneities of hydrophysical fields. A method is proposed with rather general assumptions concerning stratification, time and space scales of disturbances and internal waves, for computing the refractive indices  $n$  for different inhomogeneities. In the case of isotropy disturbances with  $n < 1$  result in more effective dispersion. The spectrum of dispersed waves



rapidly becomes isotropic. In the case of background anisotropy there is an effect of concentration of waves in directions with  $n = 1$ . It is shown that internal waves are dispersed well on an ensemble of inhomogeneities with refractive indices less than unity. The possibility of concentration of waves in some directions, with their dispersion on an ensemble of spots of a mixed fluid in an anisotropic medium (in an ocean with a vertical velocity shear), is confirmed. The transformation of the distribution of rays by directions with their dispersion on an ensemble of eddies is illustrated (passage through a group of eddies results in rotation of the wave system and its simultaneous dispersion). Figures 4; references: 9 Russian.

**Spatial-Frequency Dependence of Interference Modulation Parameters of Wide-Band Sound in Near-Surface Channel**

927N0020A Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 37 No 3, May-Jun 91 pp 455-462

[Article by V. N. Golubev and V. N. Fokin, Applied Physics Institute, USSR Academy of Sciences; UDC 534.6]

[Abstract] The experimentally determined parameters of interference modulation are compared with the results of computations made using ray theory in a near-surface channel. It was found that the detailed structure of the dependence of the speed of sound on depth exerts an influence only on the spatial scale of ordered two-dimensional structures, together creating the distribution of the intensity of wide-band sound on the distance-frequency plane. The influence of the coordinates of points of radiation and reception on the parameters of interference modulation are examined. The measurement results are compared with computed data and the possibility of prediction of the parameters of interference modulation on the basis of simple analytical models is demonstrated. It is theoretically predicted and experimentally confirmed that interference modulation of wide-band sound in oceanic waveguides can be represented in the form of the sum of independent structures associated with interference of different groups of rays with one another. The possibility of analysis and prediction of the behavior of such structures on the basis of simple analytical models is demonstrated. The spatial dependence of the characteristic features of the interference structure in the near-surface waveguide on the depth of the waveguide and the depth of radiation is investigated. The possibility of selection of groups of rays having a different number of reflections from the surface on the basis of the position of the extrema on the plane of the two-dimensional spectrum is demonstrated. Figures 5; references: 7 Russian.

**Experimental Research on Vertical Distribution of Intensity of Low-Frequency Noise in Shallow Sea**

927N0020B Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 37 No 3, May-Jun 91 pp 582-584

[Article by A. Yu. Lyubchenko and V. G. Petnikov, General Physics Institute, USSR Academy of Sciences; UDC 534.44]

[Abstract] Experimental measurements were made of the vertical structure of the field of dynamic noise in a shallow sea for different dependencies of the speed of sound on depth. Sea noise was registered with a vertical linear antenna 40 m long consisting of 12 hydrophones space equidistantly at distances of 3.5 m. The antenna was suspended vertically to a buoy at drift at a distance 50-60 m from the ship's side. Hydrophone signals were transmitted to the ship through a cable. Noise was measured far from shipping lanes and the shoreline. The noise field was registered in the frequency range 100-600 Hz. The distribution of the noise level for all the antenna receiving hydrophones had an identical monotonic character, making it possible to obtain the dependence of noise level on depth. This dependence was determined for a number of situations. Although a sound channel is observed quite rarely in a shallow sea it may appear due to various factors, such as a considerable rise of the sea floor in a region of banks. In the case of an underwater sound channel there is a quite strong dependence of mean noise levels on depth, directly related to changes in the speed-of-sound profile. On the axis of the underwater sound channel there is an increase in the noise field level which is expressed far more strongly than in the deep ocean. The form of the dependence of the speed of sound on depth was therefore found to exert a significant influence on the distribution of the intensity of the sound field with depth. Figures 3; references 3: 2 Russian, 1 Western.

**Influence of Diffraction and Interference Effects on Formation of Distant Zones of Acoustic Irradiance in Underwater Sound Channel**

927N0020C Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 37 No 3, May-Jun 91 pp 585-588

[Article by Yu. V. Petukhov, Applied Physics Institute, USSR Academy of Sciences; UDC 551.463.2]

[Abstract] The theory of normal waves was applied in a study of diffractive dispersion of acoustic field convergence zones and subsequent interference effects associated with their overlapping in an underwater sound channel for the specific experimental conditions described by A. N. Guthrie, et al. in JASA, Vol 56, No 1, pp 58-69, 1974, an article which discusses observation of a great number of such convergence zones. The Guthrie article is subjected to critical review and the conclusions drawn there are elaborated upon and in part challenged. The emphasis is on identifying the convergence zones of high numbers and determining the influence of diffraction and interference effects. The zones of acoustic irradiance observed at distances  $r > 1.6 \times 10^3$  are a result of manifestation of interference effects during overlapping of convergence zones of definite numbers. The influence of diffraction effects on the formation of a low-frequency acoustic field results in an appreciable decrease in the range of distances in which the overlapping of convergence zones will still be absent. Some specific results in the mentioned article are incorrect.

Along the propagation path there is quasiperiodic formation of distant zones of acoustic irradiance attributable to diffractive dispersion of acoustic field convergence zones and subsequent interference effects accompanying a definite number of convergence zones, increasing with an increase in distance. This results in an appreciable decrease in losses during propagation at particular frequencies, making a definite contribution to the observed slowing of the rate of dropoff of acoustic field intensity with distance. This is due in large part to a change in stratification of speed of sound along the path of source movement. Figures 5; references 5: 4 Russian, 1 Western.

#### **Computation of Effective Waveguide Height for Two-Layer Model of Shallow Sea**

927N0020D Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 37 No 3, May-Jun 91 pp 588-590

[Article by L. A. Reshetov, Leningrad Institute of Aviation Instrument Making; UDC 534.231]

[Abstract] A study was made of a two-layer model of a shallow sea consisting of a water layer of a given depth lying on a fluid homogeneous half-space. Such a waveguide model was proposed earlier and a number of simplifications were introduced which made it possible to obtain in explicit form the parameters of acoustic waves propagating in the waveguide. In particular, E. S. Lo, et al. (JASA, Vol 74, No 6, pp 1833-1836, 1983) determined the effective height  $H_{\text{eff}}$  of the waveguide by approximate solution of a characteristic equation. The approximate expression derived there has been repeatedly used when registering normal waves with numbers  $m = 1$  to  $m = 3$ . An effort is now made to determine the accuracy of this approximation with an increase in the number of the normal wave. A precise numerical solution of the characteristic equation was obtained and applied in making waveguide propagation calculations for numbers  $m = 1, 2, 3$ . Waveguide impedance and geometrical properties were taken into account, making it possible to derive precise and simplified equations useful in computing waveguide effective height in a shallow sea which are superior to those available earlier. References 3: 2 Russian, 1 Western.

### Evaluating Accuracy in Determining Position of Features on Radar Images

927N0064A Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 12, Dec 91 pp 14-16

[Article by A. A. Tokmurzin and A. N. Ugarov; UDC 528.727]

[Abstract] The results of a comparison of experimental evaluations of the accuracy in determining the position of features shown on images at 1:150 000 and 1:70 000 obtained using side-looking radars and aerial cameras with a resolution on the ground 6 and 2 m respectively are given. The accuracy evaluations were made using the results of repeated measurements of various terrain features such as the road network, hydrography, populated places, vegetation and relief. A total of 270 features were selected in a territory having a large city, suburban zone and agricultural region. Their coordinates were measured independently by seven operators using the same instrument. Enlarged radar images and topographic maps at 1:50 000 were used in this process. Accuracy was evaluated using the mean, rms and limiting errors in coordinates. The concept of accuracy class was introduced. Each class was determined by the intervals of change of the mentioned errors. A classification process was carried out in two stages. First the class was determined for each feature using each of six introduced criteria. In the second stage the results of the preliminary classification were generalized and the maximum value of the accuracy class was selected. After evaluating the quality of sighting the features were distributed by accuracy classes. A comparison of evaluations of sighting quality on radar images and photographs revealed a considerable advantage of the latter. The most successfully pinpointed features are identified. Figure 1.

### Determining Displacement of Points on Aerial Photographs Taken at Different Times

927N0064B Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 12, Dec 91 pp 17-19

[Article by R. N. Gelman and Yu. F. Knizhnikov; UDC 528.721.22]

[Abstract] A method for determining the displacement of points on aerial photographs taken at different times is described. It is based on the use of stereopairs obtained using a space-time base (stereopairs formed from photographs taken at different times from two points on a spatial base). The method was especially developed as applicable to an aerial survey. The stereoscopic observation of displacement parallaxes is the most reliable method for identifying the same point on two photographs taken at different times, but this is more complicated for an aerial survey than a ground survey because it is necessary to reckon with the total influence of displacement parallaxes and ordinary parallaxes arising as a result of noncoincidence of survey points. The

processing method must ensure separation of the displacement parallax from the total parallax. The movement of the observed points can be determined using two processing variants (each of which is described in detail). The proposed method was experimentally checked when determining the surface rate of ice movement for the Elbrus glacier Kyukyurtlyu (0.5 km wide). The aerial survey was made using an AFA-41-10 camera on an MI-8 helicopter from an altitude 4000 m in the summer of 1988. Multiple survey runs were made along and across the glacier at an interval of several days with the sun overhead. Photographs at 1:10 000 were processed by the two proposed variants using a stereocomparator, computer and an appropriate program. The results are represented in the form of vectors for the transverse runs across the glacier. The lengths of the vectors are proportional to five-day movements and can be used in computing the mean daily rates of ice movement at the glacier surface. Figures 3; references: 3 Russian.

### Brightness of Scattered Light From Searchlight Beam in Clouds

927N0062A Tomsk OPTIKA ATMOSFERY in Russian Vol 4 No 6, Jun 91 pp 570-575

[Article by A. S. Drofa and L. I. Yakushkina, Tayfun Scientific Production Association, Obninsk; UDC 551.521.3:535.36]

[Abstract] Various formulas have been derived for computing some integral characteristics of the spatial-angular distribution of brightness created by a directed light source in a scattering medium. The form of both the angular and spatial distributions is assumed to be Gaussian, but real light fields, especially at short distances from sources with narrow directional diagrams, may differ considerably from Gaussian. Accordingly, a formula is proposed for computing the brightness distribution of scattered light in the image of a directed light source observed through a cloudy medium, taking into account the geometry of the observation scheme, characteristics of the light scattering properties of the medium and stratification along the observation path. The range of formula applicability is determined by comparison with data computed by the Monte Carlo method. The comparison revealed that this formula is suitable for describing the image brightness of searchlight beams with a width of the directional diagram  $\theta_0$  satisfying the relation  $\theta_0^2 > 0.4 \tau \times \beta^2$ , where  $\tau$  is optical depth,  $\beta$  is characteristic width of the light scattering phase function in a cloudy medium. The brightness distribution of the scattered light is described well in the range of sighting angles  $< \theta_0$  with angles of deflection of the directional diagram of the searchlight from the observer not exceeding  $2\theta_0$ . Figures 2; references: 12 Russian.

### Results of Laser Sounding of Vertical Aerosol Stratification Over Western Siberia (1986-1989)

927N0062B Tomsk *OPTIKA ATMOSFERE* in Russian Vol 4 No 6, Jun 91 pp 631-637

[Article by A. V. Yelnikov, V. V. Zuyev and V. N. Marichev, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; UDC 551.501]

[Abstract] This article represents a continuation of earlier work by A. V. Yelnikov, et al. (*OPTIKA ATMOSFERE*, Vol 4, No 4 pp 117-123, 1988; Vol 2, No 5, pp 537-540, 1989). It gives the results of laser sounding of the vertical distribution of stratospheric aerosol at a wavelength 532 nm in the altitude range 10-35 km. Sounding was at nighttime in a relatively cloudless sky. The principal parameter used in analysis of aerosol stratification was the scattering ratio  $R(H)$ , retrievable from lidar signals, as proposed in one of the earlier articles. About 200  $R(H)$  measurements were made. The described lidar observations of the vertical distribution of stratospheric aerosol over Tomsk carried out during 1986-1989 indicate that there are specific annual characteristics of both summer and winter profiles. These are reflected in the total aerosol content and in the behavior of its vertical stratification. This period was characterized by a gradual disappearance of the minimum at an altitude 12-14 km and shading of the aerosol layer maximum (16-19 km). There is a clearly expressed seasonal variation of the aerosol layer maximum conforming to the behavior of tropopause altitude. The experimental data were consistent with data in the literature. Figures 4; references 14: 9 Russian, 5 Western.

### Solution of Equations for Atmospheric Lidar Tomographic Sounding

927N0062C Tomsk *OPTIKA ATMOSFERE* in Russian Vol 4 No 6, Jun 91 pp 638-644

[Article by V. V. Veretennikov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; UDC 551.510.501:535.36]

[Abstract] Inverse problems in atmospheric lidar tomographic sounding from aboard an aircraft are formulated and analytical solutions are found for two- and three-ray models. In contrast to traditional laser sounding problems, the method for retrieving the two-dimensional spatial distribution of the backscattering and extinction coefficients does not require invoking additional a priori information on the functional interrelationship between atmospheric optical characteristics or their spatial structure. The application of lidar sounding methods from an aircraft using a tomographic scheme therefore is most desirable for optically dense media with a high uncertainty and variability of the lidar ratio. Included among such media are regions of increased concentration of aerosols and absorbing gases forming as a result of effluent of industrial enterprises, fires and volcanic

activity. Further research must be directed to development of computation algorithms for solving inverse problems in lidar tomographic sounding on the basis of the analytic solutions obtained in this study with allowance for the discrete character of the real measurement data. Finally, using the developed algorithms, by mathematical simulation methods it is necessary to evaluate the spatial resolution and accuracy of solution of inverse problems and to formulate recommendations on the optimum choice of sounding polar angles for different atmospheric optical states. Figure 1; references 7: 3 Russian, 4 Western.

### Monitoring Stability of Atmospheric Optical Properties

927N0057A Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERE I OKEANA* in Russian Vol 27 No 8, Aug 91 pp 831-840

[Article by T. Z. Muldashev, V. Ye. Pavlov and Ya. A. Teyfel, Mathematics and Mechanics Institute and Astrophysics Institute, Kazakh Academy of Sciences; UDC 551.521.3]

[Abstract] The problem of monitoring the stability of atmospheric optical properties cannot be solved solely on the basis of measurements of direct solar radiation; additional information is required on atmospheric aerosol. The shortcomings of existing methods for monitoring the stability of atmospheric optical properties are discussed. The basic premise for developing the described new method for monitoring the stability of optical properties was the circumstance that in the light of modern concepts atmospheric aerosol belongs to complex polydisperse formations of several groups of particles. The composition of each of them may vary independently of the other fraction. The existence of a minimum of three groups is typical: Aitken nuclei, submicron and coarse dispersed particles with a log-normal particle-size distribution. By combining groups of particles in definite proportions and integrating their optical characteristics it is possible to describe the real aerosol scattering phase function with an accuracy adequate for many practical purposes. The spherical harmonics method is used in making computations of the absolute brightness phase functions for a cloudless atmosphere in the visible part of the spectrum. Approximate relations are derived which on the basis of observations of the brightness phase functions make it possible to determine the values of the aerosol optical depth at each specific moment in time. Figures 8; references 28: 27 Russian, 1 Western. 680

### Theory of Atmospheric Tomographic Sounding Using Two Lidars

927N0052A Tomsk *OPTIKA ATMOSFERE* in Russian No 7, Jul 91 pp 675-680

[Article by V. V. Veretennikov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; UDC 551.510.501:535.36]

[Abstract] It is demonstrated that the registry of sounding signals from each point of an investigated volume from two directions, with the additional use of a second lidar in the laser monitoring system, makes it possible, using experimental data, to retrieve simultaneously the spatial distribution of the extinction and backscattering coefficients without drawing upon a priori information on the functional dependence between them. An analytical solution of the corresponding inverse problem is obtained which is based on integration of a system of two differential equations in first-order partial derivatives. The problem really changes little when using only one lidar, but with replacement of the second lidar by a reflecting system which is irradiated by the first lidar. In contrast to airborne lidar tomographic sounding the proposed method does not require lidar movement relative to the investigated volume and is based solely on angular scanning. The most important step in processing lidar signals by the proposed scheme is computation of their logarithmic derivatives in the directions of sounding for each lidar at arbitrary points of the investigated space. Taking into account the discrete nature of real experimental data, as well as the incorrectness of the numerical differentiation problem, it can be expected that the practical application of this method will be effective when using the splines method. Figure 1; references 5: 4 Russian, 1 Western.

#### **General Description and Statistical Parameters of Atmospheric Spectral Transparency in Several Atlantic Regions**

927N0052B Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 4 No 7, Jul 91 pp 695-704

[Article by S. M. Sakerin, S. V. Afonin, T. A. Yeremina, A. M. Ignatov and D. M. Kabanov, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; UDC 551.521.3+551.591]

[Abstract] Atmospheric transparency research was carried out in a number of regions of the Atlantic Ocean and Mediterranean Sea during the 40th cruise of the Akademik Vernadskiy research ship in 1989. Aerosol optical depths were measured by the long Bouguer method at five wavelengths. The statistical parameters of variability of the range of visibility and aerosol optical depth in the marine atmosphere were analyzed in the spectral range 0.4-1.06  $\mu\text{m}$ . Research which was carried out confirmed the possibility of using the "IKOS" measuring instrument for estimating atmospheric horizontal transparency from shipboard. The general character of the collected quantitative data on atmospheric turbidities is consistent with the results of research by other authors. However, for obtaining more detailed and reliable results it is necessary to improve the instrument and algorithm for retrieving the extinction coefficients and broaden the spectral range. On the basis of statistical parameters the atmospheric aerosol optical depth over

the Atlantic Ocean can be divided into three characteristic regions: open ocean, coastal regions and the so-called "sea of gloom" (tropical zone of ocean near western coast of Africa). The open ocean is characterized not only by a maximum transparency, but also a minimum absolute variability of aerosol optical depth; the "sea of gloom" is characterized by maximum turbidities, a low relative variability of aerosol optical depth and two modes of the most probable aerosol optical depth values characteristic for two types of optical-meteorological state of the atmosphere; the aerosol optical depths in coastal regions with respect to mean values and standard deviation occupy an intermediate position, but are characterized by maximum relative variability values. Figures 4; references: 11 Russian. 712

#### **Detection of Gases Using Optoacoustic Gas Analyzer**

927N0052C Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 4 No 7, Jul 91 pp 705-712

[Article by M. Yu. Katayev and A. A. Mitsel, Atmospheric Optics Institute, Siberian Department, USSR Academy of Sciences, Tomsk; UDC 517.518.8]

[Abstract] Two processing algorithms are given for solving the problem of detection of gases using optoacoustic (OA) gas analyzers. Two detection tests are proposed for this purpose: the Bayes test, based on minimizing the mean risk, and the Neumann-Pearson test. The detection essentially involves checking of the statistical hypothesis  $H_1$  that a decision is made on the basis of the measured parameter  $y$  (measured OA signal) that the concentration  $\pi$  of the investigated gas belongs to the class of states  $X_1$  versus the alternative  $H_2$  in which the informational parameter  $\pi$  belongs to the class  $X_2$ . The results of processing of  $\text{CO}_2$  laser optoacoustic gas analyzer signals are given. The algorithms were tested using experimental data obtained by P. L. Meyer and M. W. Sigrist, who developed a  $\text{CO}_2$  laser optoacoustic system for monitoring atmospheric pollutants. The results of processing of optoacoustic signals for the detection of  $\text{C}_2\text{H}_4$  and  $\text{CO}_2$  are given in two tables. Comparison with measured  $\text{C}_2\text{H}_4$  concentrations, for example, shows that both detection algorithms can be used successfully in solving gas analysis problems using optoacoustic detectors. References 7: 4 Russian, 3 Western. 782

#### **Synthesis of Algorithm for Optimum Control of Phase Conjugation Adaptive Optical System**

927N0052D Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 4 No 7, Jul 91 pp 779-782

[Article by S. V. Butsev; UDC 681.513.5:535]

[Abstract] One of the important problems in constructing adaptive optical systems (AOS) is the writing of effective algorithms for control of the actuating elements of these systems known as wave front correctors. A



promising direction in the designing of highly accurate AOS is use of the algorithms of stochastic optimum control theory, which make it possible to formulate a law for control of AOS actuating elements optimum with respect to a minimum of the integral quadratic quality functional. This article gives a formulation and solution of the problem of synthesis of an AOS control law optimum with respect to a minimum of a quality functional taking into account the errors in correction of wave front distortions and expenditures on control. The proposed approach makes it possible to formalize the problem of functioning of a phase conjugation AOS with allowance for the dynamic characteristics of phase fluctuations caused by atmospheric turbulence and the correction system actuating elements on the basis of the theory of optimum control of dynamic systems. The synthesized algorithm ensures the best quality of functioning of a phase conjugation AOS within the framework of a formalized description of quality defined by a functional derived in this article which characterizes the accuracy in operation of the correction system and energy expenditures on control of the wave front corrector. References 3: 1 Russian, 2 Western. 906

#### **Theoretical Study of the Spectral Pattern of the Extinction Coefficient of Optical Radiation for a System of Oriented Ice Plates**

927N0043A Tomsk *OPTIKA ATMOSFERE* in Russian Vol 4 No 9, Sep 91 pp 899-906

[Article by A. G. Borovoy, A. A. Popov, and O. V. Shefer, Institute of Atmospheric Optics, Siberian Division of the USSR Academy of Sciences, Tomsk, and the Gorkiy Mariyskiy Polytechnical Institute in Yoshkov-Ola; UDC 535.2]

[Abstract] An oscillating dependence of the extinction coefficient  $\alpha$  on wavelength  $\lambda$  was obtained for a system of oriented ice plates in the infrared range. Each  $\alpha(\lambda)$  curve has a fine structure and characteristic features which make it possible to determine the average size of the ice plates. It is shown that in a crystal cloud only oriented ice plates can yield a noticeable dependence of the extinction coefficient on wavelength. Figures 4; table 1; references 7: 5 Russian 2 Western. 937

#### **Propagation and Scattering of Sound Waves in Turbulent Media (Atmosphere and Ocean)**

927N0043B Tomsk *OPTIKA ATMOSFERE* in Russian Vol 4 No 9, Sep 91 pp 931-937

[Article by V. Ye. Ostashev, Andreyev Acoustic Institute, USSR Academy of Sciences, Moscow; UDC 551.463.21:551.596]

[Abstract] The statistical characteristics of sound waves propagating in media with random inhomogeneities of the speed of sound, the density, and the velocity of the medium are calculated in a Born approximation, as well

as using geometric acoustics, smooth disturbances, parabolic equations, and the theory of multiple scattering. A new method of remote sensing of fluctuations in atmospheric humidity is proposed. References 13: 11 Russian 2 Western. 953

#### **Information System on Molecular Absorption of CO<sub>2</sub> Laser Radiation**

927N0043C Tomsk *OPTIKA ATMOSFERE* in Russian Vol 4 No 9, Sep 91 pp 938-953

[Article by O. K. Voytsekhovskaya, S. V. Kuznetsov, S. V. Sapozhnikov, N. N. Trifonova, and M. R. Cherkasov, Institute of Atmospheric Optics, Siberian Division of the USSR Academy of Sciences, Tomsk; UDC 539.534]

[Abstract] An information system has been created to provide absolute values of the absorption coefficients of atmospheric and trace gases in studies of gaseous media using a CO<sub>2</sub> laser. In addition to the characteristics of the lasing transitions of a CO<sub>2</sub> laser, the information system contains two databases: characteristics of the emission lines of a laser in five isotopic modifications of CO<sub>2</sub> gas, and the parameters of spectral lines (center, intensity, half-width, quantum identification, etc.) of atmospheric and trace gases. These were formed on the basis of calculations done using original methods. Attention was focused on evaluating the confidence level of the information. One section of the article analyzes the confidence level of the absorption coefficients for various gases. Comparisons are made with independent experimental data. Tables 9; references 36: 7 Russian 29 Western.

#### **Determining Vertical Gradient of Refractive Index of Radio Waves Near Sea Surface**

927N0037C Moscow *IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERE I OKEANA* in Russian Vol 27 No 12, Dec 91 pp 1342-1348

[Article by N. S. Zabolotnyy, L. P. Dunayenko, V. A. Malinnikov and N. M. Padalka, Moscow Institute of Geodesic, Aerial Mapping and Cartographic Engineers; UDC 551.510.62]

[Abstract] A direct analytic dependence was found between the vertical gradient of the refractive index of radio waves, determining ray curvature in the atmosphere, and the flows of momentum, heat and moisture in the atmospheric near-surface layer. Specifically, such an analytic dependence was derived for the vertical gradient of the refractive index - turbulent exchange quantity at an ocean-atmosphere interface with known values of the flows of momentum, heat and moisture, coefficient of turbulent exchange and coefficients A, B, C (dependent on meteorological parameters) in order to estimate the  $dN/dz$  value in the atmospheric near-water layer. Experimental observations of meteorological parameters were made in the North Sea region at Bor-kumriff and Elbe stations in 1979 and 1980 (2928 cases).



The spectra contain statistically significant harmonic components with periods 24, 18 and 12 hours. Allowance for the presence of these periodicities in the temporal variability of the  $dN/dz$  value in some cases makes it easier to interpret data on radio wave propagation in the atmospheric near-water layer. The proposed method for computing the vertical refractive index gives quantitative estimates of  $dN/dz$  as functions of transfer flows at the ocean-atmosphere interface and thereby makes it possible to explain the formation of great gradients of the refractive index of radio waves in the near-water layer and the refraction of radio waves itself. Figures 2; references 5: 4 Russian, 1 Western.

**Molecular Absorption of Radiation in Atmospheric Window of Relative Transparency 8-13 $\mu$ m (Review)**

927N0035A Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 11, Nov 91 pp 1187-1225

[Article by V. N. Arefyev, Experimental Meteorology Institute, Tayfun Experimental Meteorology Association; UDC 551.521]

[Abstract] This is a review of the literature on the selective and continuous components of molecular absorption in the atmospheric window 8-13 $\mu$ m registered in the laboratory and in the atmosphere during the last 20 years. Selective absorption of radiation at 8-13 $\mu$ m by atmospheric gases can be described satisfactorily by the corresponding contours of absorption lines and spectroscopic parameters of these lines given in special compilations. Although the compilations are being constantly supplemented and refined, the accuracy of the line parameters is often inadequate for computing the absorption of monochromatic laser radiation. In the transparency microwindows of the interval 8-10 $\mu$ m the contribution of selective absorption to total molecular absorption is greater than in the interval 10-13 $\mu$ m. The nature of the continuum still remains uncertain because theoretical research has not been completed and its results are frequently debatable and data from experimental measurements of continuum absorption in which the principal dependencies of the continuum on different parameters really give no answer to the question of its nature and can provide only an argument in favor of one theoretical hypothesis or another. The interpretation of special measurements, such as with external irradiation or in supersaturated water vapor, has proven to be ambiguous. Models of molecular absorption made it possible to carry out prognostic computations of the propagation of radiation at 8-13 $\mu$ m on horizontal near-surface paths, in the depths of the troposphere and in the Earth's entire atmosphere. The most transparent microwindows of the transparency window 8-13 $\mu$ m are the sectors 9.295 $\pm$ 0.085, 9.573 $\pm$ 0.011 and 10.05 $\pm$ 0.10 $\mu$ m. The latter, broadest, microwindow holds about 90 CO<sub>2</sub> generation lines, for which the transmission of the summer troposphere exceeds 78 percent. The

reviewed laboratory research on the molecular absorption of radiation in the studied range reveals that it has been possible to determine its principal qualitative and quantitative dependencies on atmospheric parameters and the possibility of its reliable description in the real atmosphere. Figures 17; references 381: 143 Russian, 238 Western.

**Radiation Flux in Slightly Absorbing Atmosphere of Arbitrary Optical Depth**

927N0035B Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 11, Nov 91 pp 1241-1246

[Article by E. G. Yanovitskiy, Main Astronomical Observatory, Ukrainian Academy of Sciences; UDC 551.521.3]

[Abstract] In an earlier study (E. G. Yanovitskiy, et al., IZV. AN SSSR: FAO, Vol 19, No 8, pp 813-823, 1983) simple formulas were derived for determining the illumination of the upper and lower boundaries of a plane homogeneous layer of the atmosphere at an arbitrary optical depth with weak true absorption. Due to the detailed tables presented there the formulas made it possible to solve a number of direct and inverse problems in atmospheric optics, such as estimation of the optical depths of clouds and the wavelengths for aerial measurements of spectral ascending and descending fluxes. Now it is shown that the functions tabulated in the earlier study make it possible not only to estimate the illuminations at the boundaries of the atmosphere, but also in an elementary way to find the projection of the vector of the radiation flux onto the axis of optical depths at any arbitrary optical depth in a slightly absorbing atmosphere. This substantially broadens the interpretation possibilities of the rigorous asymptotic theory described in the earlier study since this makes it possible to use the corresponding optical measurements at an arbitrary level within the atmosphere. Figures 6; references: 6 Russian.

**Estimating Parameters of Cloud Cover Spatial Structure Over Ocean**

927N0035C Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 27 No 11, Nov 91 pp 1247-1250

[Article by Zh. K. Zolotova and K. S. Shifrin, Oceanology Institute, USSR Academy of Sciences; UDC 551.576.1]

[Abstract] In an earlier study (IZV. AN SSSR: FAO, Vol 23, No 3, pp 279-285, 1987) the authors analyzed the transmission of solar radiation by clouds over the ocean. Continuing this work, the theoretical estimates of total radiation beneath clouds of finite dimensions are compared with observational data for cloud cover of different tenths. The comparison of computations with observations made it possible to estimate the typical

dimensions of clouds which correspond to a particular cloud cover extent. It is shown that in addition to lateral light from an isolated cloud, transmission of the cloud system will be influenced by the reciprocal illumination of clouds. With a decrease in the distance between clouds the albedo increases and system transmission decreases. A precise evaluation of this effect requires availability of empirical data on the relationship between cloud dimensions and the distance between cloud centers. The estimates presented were made within the framework of a model of noninteracting clouds. This simple model makes it possible to explain the values of the radiation transmission factor of clouds obtained during observations. References 4: 3 Russian, 1 Western.

#### **Changes in Energy-Bearing Part of Spectrum of Surface Sea Waves in Internal Wave Field Observed Using Remote Data**

927N0035D Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 27 No 11, Nov 91 pp 1263-1269

[Article by M. I. Mityagina, V. G. Pungin, A. V. Smirnov and V. S. Etkin, Space Research Institute, USSR Academy of Sciences; UDC 551.46.062.6]

[Abstract] Internal waves to one degree or another exert an influence on the entire interval of the spectrum of wind waves and therefore on natural and scattered radiation from the sea surface in all ranges of electromagnetic waves. Four-wave resonance with the participation of three surface waves and one internal wave is impossible, but internal waves can exert an appreciable influence on the energy-bearing component of wind waves due to five-wave resonance, involving a change in the dynamics of modulation instability due to their self-effect caused by periodic currents in the field of an internal wave. Although such a process was studied earlier, attention was given only to modulation of the direction of internal wave propagation. It is now demonstrated theoretically and experimentally that such an effect may lead to an intensification of the modulation of surface waves in other directions. The spatial evolution of interaction between gravity energy-bearing waves at the ocean surface and internal waves of a shallow thermocline in deep water is examined on the basis of aerial radar and optical images of the ocean surface. The experimental data were obtained along the shores of the Kamchatka Peninsula using airborne side-looking radars operating at 2.25 cm and a camera. The measurements were made 50 km from the coast near the continental slope where the depths were 1500-700 m. It is shown that radar and optical images, mutually supplementing one another, make it possible to observe a new type of interaction between gravity surface waves and internal surface waves in deep water. Figures 5; references: 4 Russian.

#### **Theoretical and Experimental Validation of Method for Computing Vertical Gradient of Refractive Index at Ocean Surface in Geodetic Refractometry Problems**

927N0034A Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 2, Mar-Apr 91 pp 3-15

[Article by L. P. Dunayenko, docent, candidate of physical and mathematical sciences, V. A. Malinnikov, docent, candidate of physical and mathematical sciences, N. M. Padalka, senior instructor, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.2/.3]

[Abstract] A direct analytic dependence was established between the vertical gradient of the refractive index of radio waves, determining ray curvature in the atmosphere, and the flows of momentum, heat and moisture in the atmospheric near-water layer. It is assumed that the near-water layer is statistically stationary and homogeneous and has an approximately constant thickness. Within this layer the flows of heat, moisture and momentum are constant with depth. The proposed method for computing the vertical refractive index is of both theoretical and practical interest. The method gives quantitative estimates of the quantity  $dN/dz$  directly from the transfer flows at the ocean-atmosphere interface and thereby makes it possible to explain the processes of formation of steep gradients of the refractive index of radio waves in the near-water layer and the refraction of radio waves itself. The presented materials reveal good possibilities for using remote methods for sounding the atmosphere for determining the characteristics of refraction in the near-water layer of the atmosphere. [Note: Virtually the identical material is presented in an article by N. S. Zabolotnyy, et al., IZV. AN SSSR: FIZIKA ATMOSFERY I OKEANA, Vol 27, No 12, pp 1342-1348, 1991.] Figures 2; references 4: 3 Russian, 1 Western.

#### **Least Squares Method in Processing of Astronegatives Using Projective Transforms**

927N0034B Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 2, Mar-Apr 91 pp 49-58

[Article by M. S. Urmayev, professor, doctor of technical sciences, and V. M. Bezmenov, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.28 523.8]

[Abstract] Although a number of methods already exist for the processing of astronegatives by use of projective transforms for determining the spherical coordinates of celestial bodies, a simpler and more effective method is now proposed for the processing of astronegatives which is based on projective transforms with use of evaluation

by the least squares method. The basis for the method is a vectorial interpretation of the principal relations in projective geometry. The proposed method makes it possible to include in simultaneous processing  $n$  reference stars, in the processing remaining within the limits of projective space. A formula is derived for the relationship between the coordinates measured on an astronegative and the direction to an object in space. Formulas are given for computing the coefficient of parametric equations. It is shown that the generalized least squares method can be employed when using the principal relations of projective geometry (anharmonic ratios) in photogrammetry and photographic astrometry. It is possible to construct graphic extensions of star phototriangulation, applying projective transforms, and adjust them by the least squares method. Figure 1; references: 9 Russian.

**Differential Refinement of Initial Conditions of Motion of Artificial Earth Satellites Using Results of Photogrammetric Processing of Space Photographs**

927N0034C Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA in Russian No 2, Mar-Apr 91 pp 95-102

[Article by T. K. Dedova, graduate student, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers; UDC 528.72:629.783]

[Abstract] Earlier studies by the author (IZV. VUZov: GEODEZIYA I AEROFOTOSYEMKA, No 3, pp 47-55, No 6, pp 59-67, 1990) demonstrated the possibility of an unambiguous refinement of the initial values of all six elements of a Keplerian orbit when using the coordinates of points on the Earth's surface on topographic photographs oriented in inertial space and the orienting angles of space survey bases. Building on this groundwork, a method is described for the differential refinement of the initial conditions of motion of an artificial earth satellite using the results of photogrammetric processing of space photographs. It is assumed that satellite motion in circumterrestrial space is adequately described by the dependencies of the two-body problem. The point of departure is a model, represented by formulas (1)-(5),

used in examining a case when the coordinates of surface points are directly measured on topographic photographs oriented in inertial or Greenwich coordinate systems. These measurements are processed by the least squares method. Procedures are given for applying the mathematical model of motion for more precise determination of the initial conditions of motion by processing the mentioned measurements. References: 5 Russian.

**Influence of Stage of Wind Wave Development on Dynamics of Atmospheric Boundary Layer Over Ocean**

927N0033A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 3, Mar 91 pp 64-70

[Article by N. Z. Ariel, R. S. Bortkovskiy, A. V. Murashova, Ye. D. Nadezhina and V. V. Simonov, Main Geophysical Observatory; UDC 551.510.522:551.466.3]

[Abstract] The dependence of the dynamic characteristics of the atmospheric boundary layer over the ocean on the stage in development of wind waves was determined for different velocities of the geostrophic wind. The research was carried out on the basis of concepts concerning the drag coefficient as a function of wind speed and the age of waves using a theoretical model of the atmospheric boundary layer. It was established that allowance for the stage in development of wind waves is necessary in regions of intensive cyclonic activity. The use of the derived dependence  $u_*(G)$  in comparison with the traditional dependence  $u_*(U_{10})$  gives an obvious advantage in problems of interaction between the ocean and the atmosphere. The presented materials show that with a known geostrophic wind the flow of momentum and wind speed in the near-water layer have a significant dependence on the stage in wind wave development. Moreover, the stage in development of wind waves is an important parameter both in computations of turbulent flows and in numerical short-range prediction models with any clearly expressed nonstationary processes, such as in energy-active regions of the ocean in seasons of intensive cyclonic activity. In these same cases it is necessary to take the nonstationary terms in the model of the atmospheric boundary layer into account. Figures 3; references 23: 14 Russian, 9 Western.

### Carbon Dioxide Exchange With Atmosphere and Carbon Budget in Pacific Ocean

927N0076A Moscow DOKLADY AKADEMII NAUK  
in Russian Vol 320 No 6, Oct 91 pp 1470-1474

[Article by O. K. Bordovskiy and P. N. Makkaveyev, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow; UDC 551.464.626]

[Abstract] The exchange of CO<sub>2</sub> between the Pacific Ocean and the atmosphere was estimated, its intraannual variability was traced and the role of this ocean in the global cycling of carbon was determined. Observational data on pH, total alkalinity, temperature, salinity and oxygen in surface waters obtained on more than 230 expeditions were used. Mapping was carried out with averaging by 10° grid squares for each month for a 20-year period. A 12-month map accompanying the text shows that in the Pacific Ocean there are regions of both constant release of CO<sub>2</sub> into the atmosphere and regions of its constant absorption. It is constantly released in a narrow equatorial zone and is absorbed equally constantly during the entire year in the tropical zones of the northern and southern hemispheres. Beyond these zones there are considerable seasonal changes in both hemispheres. In computing the annual exchange of CO<sub>2</sub> between the ocean and atmosphere the fluxes were computed by two methods: simple mass exchange equations and a film model. Both methods gave similar results. A study of the contribution of different latitude zones to the total exchange revealed that the tropical latitudes account for more than 2/3 of all the CO<sub>2</sub> absorbed by the ocean. The remainder is absorbed in the latitude zones extending to 40°N and 50°S. The principal source of CO<sub>2</sub> in the Pacific is the equatorial region and the waters located to the south of 50°S. In the Pacific Ocean as a whole 3.3-4.2 million tons of CO<sub>2</sub> are received from the atmosphere. Proceeding on the basis of these and other data, the absorption (in percent) of anthropogenic CO<sub>2</sub> in the Pacific Ocean is estimated, with allowance for the great many other factors involved. This ocean accounts for 30-40 percent of such absorption in the world ocean. Figure 1; references 15; 10 Russian, 5 Western.

### Variations in Warming Influence of Oceans on Global Climate

927N0066A Moscow DOKLADY AKADEMII NAUK  
SSSR in Russian Vol 320 No 1, Sep 91 pp 70-73

[Article by G. V. Alekseyev, I. A. Podgornyy, and P. N. Svyashchennikov, Arctic and Antarctic Scientific Research Institute, Leningrad; UDC 551.58]

[Abstract] Comparison of anomalies in heat contrast between the land and ocean in the zone of the maximum of their climatic values (40-70°N) and anomalies of mean zonal temperature indicate strong negative correlations between them in winter and weak positive anomalies in summer. There is an inverse dependence of anomalies of mean annual temperature in the region

25-85°N on anomalies of the amplitude of its annual variation. Local extremal negative correlations are observed in the polar regions and near-polar parts of the continents where the year-to-year variability of albedo is small. In order to clarify the significance of these and other similar patterns model computations were made using the energy budget relation. Model evaluations of the signs on the correlations between anomalies of thermal contrasts and mean temperature in the atmosphere-ocean-land system are presented which correspond to tabulated empirical data. With time smoothing of the empirical data in the case of an averaging region 25-85°N there is a change in positive correlations in June to negative correlations with their gradual intensification with an increase in the smoothing interval. For January data there is first a loss of correlation at scales about 20-25 years and then again an intensification of negative correlation at great scales to -0.87. The approximate model estimate of the steady nonlinear change in mean zonal-mean annual air temperature caused by strengthening (weakening) of zonal atmospheric circulation, which corresponds to deviations of land-ocean contrasts from the climatic norms in the range +/-10 K and with a thickness of the active layer 50 m, is +/-0.35K. A full analysis of such data indicates that in the observed changes in current climate there is a significant internal "oceanic" component. Figure 1; references 6; 5 Russian, 1 Western.

### Geochemical Classification of Polluted Ground Water

927Q0060A Moscow SOVETSKAYA GEOLOGIYA  
in Russian No 11, Nov 91 pp 78-87

[Article by S. R. Kraynov and V. P. Zakutin, All-Union Scientific Research Institute for Hydrology and Engineering Geology; UDC 556.314:556.388]

[Abstract] Great changes are occurring in the chemical composition of ground water, especially in the upper aquifers. In some regions these changes have been so significant that the water has acquired noncharacteristic geochemical properties and contains considerable quantities of anomalous chemical elements (Fig. 1 is a reproduction of the periodic table with an indication of the elements detected in polluted ground water and the magnitude of their maximum concentrations in mg/liter; a table gives geochemical types of polluted ground water). Most of the pollutants entering the ground water are geochemically active. With their entry into ground water there is a change in the general geochemical properties of the ground water. The full range of geochemical properties of polluted ground water affected by industrial, agricultural, communal and other pollutants leads to the formation in these waters of only a strictly defined and limited set of geochemical situations expressed through the total Eh-pH indices of these waters. The following subjects are outlined: new geochemical phenomena transpiring in ground water under influence of pollutants; formation of new geochemical types of ground water; increase in areas of



occurrence of alkaline and acidic ground water; reduction of redox potential of ground water and inversion of their redox zonality; change in forms of migration of chemical elements in ground water and broadening of Eh-pH ranges of their migration in ground water. The most important modern problems in geochemical study of ground water pollution are briefly discussed: prediction of changes in chemical composition of ground water under influence of pollutants; determination of limiting admissible pollution loads on ground water of different geochemical types; monitoring ground water quality. Figures 3; references 10: 7 Russian, 3 Western.

**Simulation of Microclimate Disturbances From Reservoirs of Nuclear, Thermal and Hydroelectric Power Plants and Artificial Fog Dispersal**

927N0058A Moscow *METEOROLOGIYA I GIDROLOGIYA in Russian* No 11, Nov 91 pp 27-35

[Article by V. I. Khvorostyanov, Central Aerological Observatory; UDC (551.584.33:621.0:551.509.615).001.57]

[Abstract] The structure of a three-dimensional nonstationary numerical model is described and is applied in computations of man-induced mesoscale meteorological processes. The article gives the results of computations of changes in microclimate and fog formation in the neighborhood of cooling reservoirs of nuclear power plants, thermal electric power plants and along unfreezing rivers below hydroelectric power plants. Procedures are described for the artificial crystallization of fogs for lessening their negative impact. When there is a not excessively high water body temperature and a quite low ambient temperature a fog can be crystallized from the leeward side already at close distances to the water body, which thereby makes it possible to provide fog protection for nearby villages and technical structures (although with exceptions). The described numerical experiments demonstrated the applicability of the artificial crystallization method for evaporation fogs associated with nonfreezing water bodies and also revealed the limitations on this method, determined by the thermal load on a water body. This makes it possible to proceed to field experiments, although there is a need for further numerical experiments with a wide range of meteorological conditions and water body parameters. Such research must be carried out when planning, constructing and operating power plants. Figures 4; references 17: 14 Russian, 3 Western.

**Ecological Safety and Possible Development Strategies**

927N0053A Moscow *IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOGRAFICHESKAYA in Russian* No 6, Nov-Dec 91 pp 5-13

[Article by V. M. Kotlyakov, K. S. Losev and V. F. Grakovich, Geography Institute, USSR Academy of

Sciences; All-Union Institute of Scientific and Technical Information; UDC 910.1:911.2]

[Abstract] The Earth's ecological status and the factors giving rise to natural and man-made ecological catastrophes are reviewed in depth. The authors suggest two possible approaches for contending with the ecological crisis. First, by preserving slightly disturbed biota capable of ensuring the balance of cycling of biogens and environmental stability. This would require a decrease in the fraction of man's consumption of biospheric production and include ordering of population increase through family control programs. This would automatically reduce industrial production and power consumption. Second, by replacing the biosphere by centrally controllable economic systems for waste-free technology and artificial biotic associations. But then not less than 99 percent of all energy and material resources would be expended in maintaining a balanced cycling of matter and stabilizing the environment and less than 1 percent would remain for the development of mankind. A reduction in population and family planning would be necessary. A necessary condition for long-range assurance of global and regional ecological safety, and therefore stable socioeconomic development, is preservation of a slightly impaired biosphere in which the biota satisfies the Le Chatelier principle. For this purpose it is first of all necessary to have global ecological monitoring using all observation systems, especially monitoring of biogeochemical cycles, for confirming indirect evaluations of impairments of cycles of biogens, especially carbon, and detection of regions with strong impairments of the synthesis and decomposition cycles. Since there is every reason for assuming that the Earth is already greatly overpopulated, immediate efforts are required for studying ecological-demographic problems, stability of the human genotype and family planning. There is a need to work out and adhere to principles for the correct distribution of unshared world resources, validation of correct quotas and limits on the use, for example, of forest resources, and introduction of limits on different forms of pollutants. Protective measures are being implemented far more slowly than the environment is being destroyed. All plans for expanding material production must be viewed through the prism of the ecological imperative; tunnel vision is incompatible with the goals of stable socioeconomic development. References: 8 Russian.

**Priorities in Global Ecology**

927N0053B Moscow *IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOGRAFICHESKAYA in Russian* No 6, Nov-Dec 91 pp 14-20

[Article by K. Ya. Kondratyev, Limnology Institute, USSR Academy of Sciences; UDC 910.1:911.2]

[Abstract] The priorities of global ecology and the requirements on observational data for environmental and biospheric research are discussed. The approaches to validation of priorities in the global changes programs

drawn up in the United States and France are examined. The fundamental importance of research on dynamics of the biosphere and the need for the cooperation of specialists in the field of the natural and social sciences is stressed. It is clear that the present-day emphasis on addressing this key issue is woefully inadequate at both national and international levels. There is a definite need for discussing global changes in order to sustain favorable living conditions both in the near future and in the coming century by holding a special UN conference. Its objective would be to define priorities, stimulate research and development work and implement an international program. None of these goals have been adequately reckoned with under the International Geosphere-Biosphere Program nor was the Second World Climate Conference nor the Washington conference of February 1991 a success in this respect. In the latter case emphasis continued to be on stereotypes of global warming caused by an increase in the concentration of greenhouse gases, with failure to give full allowance for the great many other factors responsible for changes in global climate. References 17: 10 Russian, 7 Western.

#### **Geographic Principles for Preventing and Liquidating Consequences of Natural and Man-Made Catastrophes**

927N0053C Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOGRAFICHESKAYA in Russian No 6, Nov-Dec 91 pp 40-54

[Article by Yu. G. Puzachenko, A. K. Borunov, A. V. Koshkarev and V. S. Skulkin; Evolutionary Morphology and Ecology of Animals Institute, USSR Academy of Sciences; Geography Institute, USSR Academy of Sciences; UDC 910.1:911.2]

[Abstract] The USSR has now worked out a national program for dealing with catastrophes, a program which is already outdated and at least 10-15 years behind the technical possibilities. The systems in place throughout the country do not make use of available experience, are inadequately responsive and are not working toward improvement. It is imperative to increase the competence of all directors of pertinent agencies at all levels since as of today even the most perfect scientifically validated recommendations and the most perfect databases can be of little help. National leaders seem unable to comprehend the magnitude of such events and fail to understand what resources must be brought to bear to reckon with them. The long-time tradition of shrouding catastrophes in secrecy must end once and for all. Against this background, ecological catastrophes are examined in the light of the general theory of catastrophes. The scientific and methodological principles for investigating and simulating critical situations in the system of ecological relationships are outlined. The "ecological safety" concept is elaborated. The development and use of specialized geoinformation systems is discussed and the objectives, structure and conditions

for operation of an ecological safety service are presented. The role of geographers in solving these problems is stressed. References 24: 17 Russian, 7 Western.

#### **Impact of Thermal Electric Power Plant on Environment**

927N0051B Moscow INZHENERNAYA GEOLOGIYA in Russian No 5, Sep-Oct 91 pp 78-82

[Article by J. Dzievanski, Center for Environmental and Natural Resources Protection, Polish Academy of Sciences, Krakow; UDC 624.131]

[Abstract] The unfavorable impact of thermal electric power plants on the environment includes the alienation of considerable land areas from agricultural and forestry uses, discharge of a great quantity of pollutants into the atmosphere and thermal and other pollution of surface and ground waters. A multisided environmental protection approach to the problem of impact of thermal electric power plants on the environment requires study of changes in its individual components in different stages in construction and operation of the facilities constituting part of the power plant system, including during the site selection period itself. The results of multiyear research carried out in the neighborhood of Polonets thermal electric power plant in Poland are presented. Separate sections deal with the pertinent characteristics of the geological medium, air medium, agricultural and forested lands. A number of conclusions of a practical and methodological character are drawn. Recommendations are given on further research during the period of start up and initial stage of plant operation and measures are proposed for lessening the consequences of power plant operation expressed in the environment. The experience accumulated in this work (and possibly even specific results) will be applicable to the areas of operation of other industrial enterprises. 994

#### **Effect of Clouds on the Detectability of Trends in UV-B Irradiance Caused by a Decrease in Total Ozone Content**

927N0043D Tomsk OPTIKA ATMOSFERE in Russian Vol 4 No 9, Sep 91 pp 987-994

[Article by A. V. Belyavskiy, V. M. Zakharov, and G. M. Kruchenitskiy, Central Aerological Observatory in Dolgoprudnyy, and the Ukrainian Regional Scientific Research Hydrometeorological Institute, Kiev; UDC 551.521.3:535.36]

[Abstract] This article attempts to view the interdependence of trends in the total ozone content and UV irradiance in a new way, namely, by estimating the detectability and significance of changes in UV irradiance due to changes in the total ozone content on the background of natural variability due to cloud cover changes. The importance of this factor is stressed by all researchers, but it is very difficult to consider it directly in transfer equations. Here the authors limit themselves



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